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(54) IMPROVEMENTS IN OR RELATING TO IRON OXIDE MATERIAL FOR SMELTING

(71) We, THYSSEN (GREAT BRITAIN) LIMITED, a British Company, of Bynea Industrial Estate, Llanelly, Carmarthenshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to iron oxide material for smelting and to a method of producing iron from finely divided iron oxide material.

In certain processes in the iron and steel industry, iron oxide material is produced as a very fine dust. In blast furnaces, for example the fume dust contains finely divided ferric oxide. This material is also present in the flue dust from LD convertors. At present, these finely divided metal oxide dusts have a low commercial value because their fineness makes re-use difficult. It is costly and troublesome to dispose of this material. It is one of the objects of the present invention to enable such material to be usefully employed.

According to one aspect of the present invention, a method of producing iron from finely divided iron oxide material comprises the steps of forming the finely divided iron oxide material with powdered coal or coal dust containing less than 8% by weight of volatile material or powdered coke or coke dust into briquettes using a binding agent including carbon black and a thermosetting resin which gives carbon on carbonisation and charging the briquettes into a blast furnace. The iron oxide may be flue dust or fume dust but some or all of this may be replaced by powdered mill scale or rust. A particular advantage of this method however is the ability to utilise flue dust or fume dust.

In using the above method, the iron oxide material is combined in the briquettes with coal or coke as a reducing agent. Such briquettes may be fed directly into a conventional blast furnace. Whilst it would be possible to charge a furnace solely with such briquettes, in practice, the briquettes would be added as part of a charge, the remainder of the charge being conventional materials, for example iron ore and coke. In order to utilise a briquette in a blast furnace, the briquette must have adequate physical strength, particularly when it is carbonised. The finely divided oxide material must not be immediately released by disintegration of the briquette. It will be borne in mind that this finely divided material may be fume dust or flue dust as previously described; such finely divided powder can readily be carried away with the outgoing gases from a blast furnace and thus the briquette must hold this finely divided powder until the oxide is reduced.

According to one aspect of the present invention there is provided a briquette comprising finely divided iron oxide in combination with powdered coal or coal dust formed from a coal containing less than 8% by weight volatile material or powdered coke or coke dust together with between 1¼% and 2¾% by weight of carbon black and between 2½% and 4% of a thermosetting binding resin which gives carbon on carbonisation, the proportion of oxide material and coal being such there is an excess of carbon beyond the stoichiometric quantity required for reduction of the oxide. The proportion of carbon black is preferably between 1½% and 2½% and is preferably made substantially 50% of the weight of the resin. The amount of resin is preferably between 2½% and 3½%.

The invention furthermore includes within its scope a method of making a briquette comprising the steps of mixing a finely divided iron oxide with powdered coal or coal dust formed from a coal having less than 8% by weight of volatile material or powdered coke or coke dust together with between 2½% and 4% by weight of a ther-

mosetting binding resin which gives carbon on carbonisation and between 1¼% and 2¾% by weight of carbon black, the carbon black being formed as a suspension in water and mixed with the other materials, the mixture then being formed into briquettes and the resin cured. As stated above, the amount of resin is preferably between 2½% and 3½% and the amount of carbon black is preferably between 1½% and 2½%. The amount of water is kept to the minimum necessary for forming a mouldable paste and is typically 8 parts by weight for every 100 parts of the remaining materials.

These briquettes make use of carbon black in suspension in water. Although carbon black is widely used in industry, carbon black paste formed of carbon black and water is available as a waste product from oil refineries and carbon black manufacturers, such material generally resulting from wet scrubbing gas cleaning operations. In the briquettes of the present invention use is made of this carbon black paste to enable briquettes of adequate strength to be made from coal or coke dust or powder and the oxide material such as the finely divided ferric oxide known as fume dust or flue dust. The intimate mixture of the very finely divided carbon with the oxide material increases the physical strength of the briquettes both in the green stage before they are cured (when the van der Waals' forces give cohesion to the material) and also in the cured stage where the carbon black assists in filling the voids in the coarser coal or coke material. However more particularly during the smelting operation, the intimate mixture of the carbon black with the oxide material both increases the strength and facilitates the reduction of the oxide material in the briquettes. The increased strength at the high temperatures comes from the carbon entering the lattice formed by the resin. With this increased strength, this chemical process can thus proceed without the briquette disintegrating and with a reduction in the necessity for carbon monoxide to come into contact with the finely divided oxide material. This form of briquette therefore enables the oxide material to be reduced without releasing the finely divided oxide material. The possibility of escape of this finely divided material with the outgoing gases is thus greatly reduced.

The invention is thus particularly applicable to utilising the finely divided iron oxide available as fume dust or flue dust. In order to ensure adequate strength of the briquettes, it is preferred to have an excess of coal or coke and typically the amount of iron oxide is between 20% and 40% of the total weight of the briquette. The oxide content may be as high as 45% but the upper limit in practice is determined by the difficulty arising from the stickiness of the mixture in making the briquettes. For this reason it is usually preferred to use about 40% iron oxide. Since the briquettes would normally be made in order to utilise the iron oxide material, the amount of that material in the briquettes would normally be made as high as possible consistent with the above limitations. The coal is a low volatile coal and preferably an anthracite with less than 8% volatiles (known as a high rank anthracite) is employed. For this purpose, anthracite duff such as would pass a ⅛th inch sieve is conveniently employed. Such anthracite duff comprises the finer materials obtained when washed anthracite from a mine is screened.

The resin may be a phenolic resin and conveniently is a phenylformaldehyde resin although other thermosetting resins such as melamine or a urea-based resin or an aniline-based resin or a furan resin or a furfural alcohol resin may be employed.

In order to improve the green strength of the briquettes ½ to 1½% by weight of a starch may be mixed with the oxide, coal or coke, resin and carbon black and typically 1% of a gelatinized starch is employed.

The iron oxide may be fume dust or flue dust as previously described or it may include, in part or as a whole, rust or mill scale in powdered form.

Briquettes as described above formed from iron oxide may be fed into a conventional blast furnace. As previously explained, they would normally be used as only part of the charge of the blast furnace, depending on the composition of the oxide dust.

The following is a description of one example of the invention:— Briquettes were made by mixing 40% by weight of flue dust or fume dust with 2% carbon black, 4% phenylformaldehyde resin and 1% gelatinised starch and the balance high rank anthracite dust which would pass a ⅛th inch sieve. The carbon black was used as a suspension in water and sufficient water was added to the mixture to form a mouldable paste. After mixing, the material was formed into briquettes using a briquette moulding machine such as is employed for making coal briquettes. The moulded briquettes were then passed through a curing oven at a temperature such as to cure the resin.

The briquettes formed in this way had a high compressive strength and could be used as part of the charge in a conventional blast furnace. At high temperatures in the furnace, the carbon black combines with the carbonised resin to form a carbon lattice giving a relatively high strength permitting the reduction of the iron oxide to proceed before the briquette disintegrates.

WHAT WE CLAIM IS:—

1. A method of producing iron from finely divided iron oxide material comprising the steps of forming the finely divided iron oxide material with powdered coal or coal dust containing less than 8% by weight volatile material or powdered coke or coke dust into briquettes using a binding agent including carbon black and a thermosetting resin which gives carbon on carbonisation and charging the briquettes into a blast furnace.

2. A method as claimed in claim 1 wherein the iron oxide material comprises fume dust from a blast furnace.

3. A method as claimed in either claim 1 wherein the iron oxide material comprises flue dust from an L D convertor.

4. A method as claimed in either claim 2 or claim 3 wherein the iron oxide material also includes mill scale or iron rust in powdered form.

5. A briquette comprising finely divided iron oxide in combination with powdered coal or coal dust formed from a coal having less than 8% by weight volatile material or powdered coke or coke dust together with between 1¼% and 2¾% by weight of carbon black and between 2½% and 4% by weight of a thermosetting binding resin which gives carbon on carbonisation, the proportion of oxide material and coal being such that there is an excess of carbon beyond the stoichiometric quantity required for reduction of the oxide.

6. A briquette as claimed in claim 5 wherein the proportion of carbon black is between 1½% and 2½% by weight.

7. A briquette as claimed in claim 5 wherein the amout of carbon black is substantially 50% of the weight of resin.

8. A briquette as claimed in any of claims 5 to 7 wherein the amount of resin is between 2½% and 3½% by weight.

9. A briquette as claimed in any of claims 5 to 8 wherein the amount of iron oxide is between 20% and 45% by weight.

10. A briquette as claimed in claim 9 wherein the amount of iron oxide is between 20% and 40% by weight.

11. A briquette as claimed in any of claims 5 to 10 wherein the coal is anthracite.

12. A briquette as claimed in any of claims 5 to 11 wherein the resin is a phenolic resin.

13. A briquette as claimed in claim 12 wherein the resin is a phenylformaldehyde resin.

14. A briquette as claimed in any of claims 5 to 11 wherein the resin is melamine or a urea-based resin or an aniline-based resin or a furan resin or a furfural alcohol resin.

15. A briquette as claimed in any of claims 5 to 14 wherein at least some of the iron oxide is fume dust from a blast furnace or flue dust from an L D convertor.

16. A briquette as claimed in any of claims 5 to 14 wherein at least some of the iron oxide is mill scale or iron rust in powdered form.

17. A method of making a briquette comprising the steps of mixing a finely divided iron oxide with powdered coal or coal dust formed from a coal having less than 8% by weight of volatile material or powdered coke or coke dust together with between 2½% and 4% by weight of a thermosetting binding resin which gives carbon on carbonisation and between 1¼% and 2¾% by weight of carbon black, the carbon black being formed as a suspension in water and mixed with the other materials, the mixture then being formed into briquettes and the resin cured.

18. A method as claimed in claim 17 wherein the amount of resin is between 2½% and 3½% by weight.

19. A method as claimed in either claim 17 or claim 18 wherein the proportion of carbon black is between 1½% and 2½% by weight.

20. A method as claimed in any of claims 17 to 19 wherein a starch is mixed with the oxide, coal or coke, resin and carbon black, before curing the resin.

21. A method as claimed in claim 20 wherein the proportion of starch is between ½% and 1½% by weight.

22. A method as claimed in either claim 20 or claim 21 wherein the starch is a gelatinized starch.

23. A method as claimed in any of claims 17 to 22 wherein the iron oxide is fume dust from a blast furnace or flue dust from an L D convertor.

24. A method of producing iron from finely divided iron oxide material substantially as hereinbefore described.

25. A briquette substantially as hereinbefore described in the foregoing example.

26. A method of making a briquette substantially as hereinbefore described with reference to the foregoing example.

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